Thin Wall 1” – 6” OD Pipework NDT Digital Radiographic Inspection Technology

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Abstract

*Pipework can now be radiographically inspected with **C**omputed **D**igital **R**adiography **T**echnology using **flexible reusable digital imaging**. The digital radiography offers an alternative technology that replaces conventional films radiography, dark rooms, wet chemistry. Radiographic quality achieved meets with the acceptance code standards of geometric system unsharpness, contrast and defect sensitivity. The main advantage is that it reduces costs of NDT, can provide faster results, meets with the environmental green policy, and eliminates ageing of radiographic images. Further it simplifies the quality control processes with electronic archiving of data of the various inspections carried out in this field. This technology is not new but recently developed to suit industrial radiography needs by incorporating portability, affordability and to retrofit its existing working practice. Cost benefits of 30 to 35% may be realised with the CIT Digital Radiographic technology.*

Introduction

Power stations, nuclear power plants and petrochemical installations all extensively use 1” to 6” diameter pipework for their processing plants. NDT radiographic inspection is the preferred technology for *austenitic steel, grb, steel and alloy piping.*

There is now an economic drive of every department undergoing painstaking methods of cost reduction of their operations. This is one method of how costs can be reduced and improves productivity.

Hence this new method aimed towards replacement of conventional method with digital radiography enabling the business target objectives to be realised.

These cost savings are released with the elimination

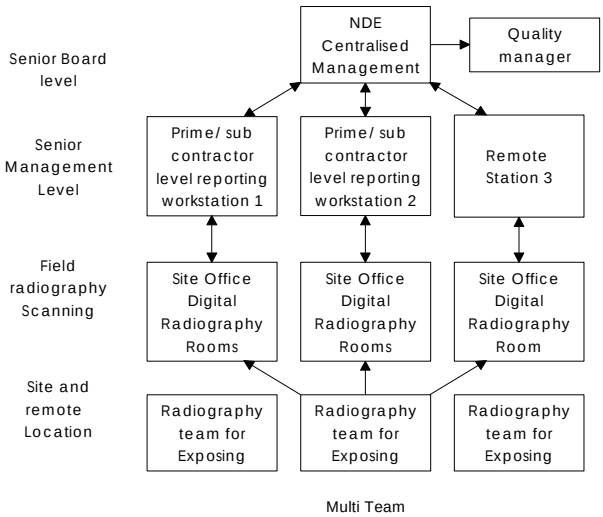
of special fixtures, film adapters, film processing equipment and dark rooms. Its various Health and Safety issues of COSHH have to be addressed. Up until now there was not a serious alternative and infrastructure had stuck to this process for the last few decades. These do add up to the costs of revenue on a yearly basis. Further there is cost associated with administration of archiving films, reporting, traceability and the time factors. Why go through these laborious methods when now there is an alternative, which is described in this paper?

Overview

The modern NDT digital radiography department facility could consist of

- Quality Manager’s NDT workstation with central electronic archiving of all the production plant’s
  - NDE information
  - Inspection condition management
  - Corrosion, erosion assessment and condition management
  - Maintenance programmes
  - Historical legacy information
- Auditors NDT workstation
- Inspectors NDT workstations
- Operator NDT digital radiography capture systems
- Field digital radiography systems with Digital Imaging Plate technology.
- Radiation devices X-rays, Se75, or Iri 192, Co 60 etc/. Portable X-ray generator 160kV or 120kV
- Jigs and fixtures for site radiography

This structured approach illustrates the careful modern planning strategy.



The above facility will have host of the following features

- Electronically archive of all the inspection product components, their technical material, traceability details,
- Inspection techniques, methods, procedures of every item under examination

NDT Digital Radiography Inspection with Pipework

- Radiographic images of pipe welds
- Radiographic technique along with its radiographic isometric

- Reference standards in the form of codes, images, Level IIII acceptance, and customer acceptance
- Actual product data and its radiographic information archived to meet the quality life time records of various end customers.
- Information with reference to its location

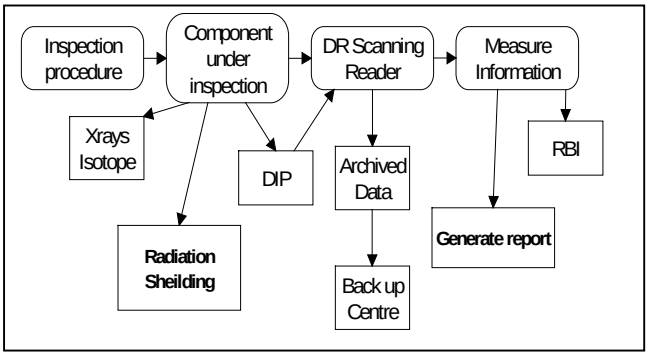
The CIT technology described above is a total departmental or organisation solution that in fact develops the various processes by using concepts with its main methodology.

The CIT digital radiography is a total solution that in fact is complete inspection technology for inspection of pipework from 1" to 6" diameters. Outside this document, sizes of up to 84" OD have been inspection.

4" Pipe

The Scope of Work

The scope of the inspection technology is as depicted below: -



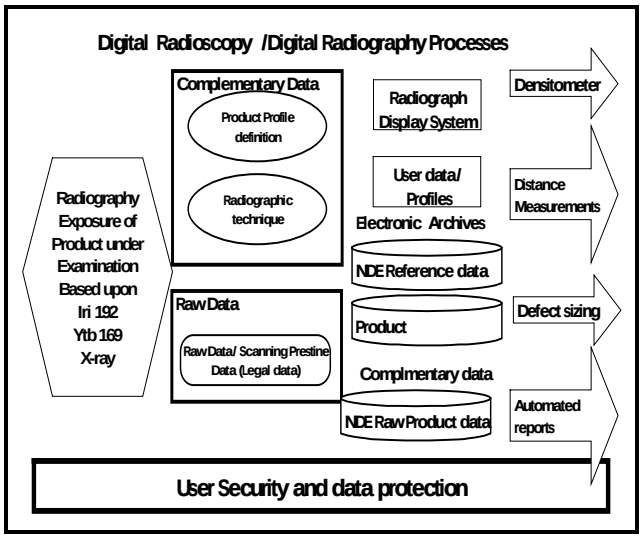
The above processes are all integrated into one solution, which could be used as a single standalone or multi user department.

The entire information management system is treated as a fault tolerant mission critical solution to maintain the lifetime quality records.

The Radiographic Methods

Currently various radiographic techniques exists for the different pipework. The same radiographic techniques methods are used, the main differences are that digital radiography requires reduced radiation source strength and exposure time and uses reusable flexible Imaging Plates.

Instead of using an Xray film in a jacket one uses a digital radiography imaging flexible plate. The welds are exposed to this flexible imaging plate and then are scanned using digital radiographic scanner. The image is displayed on the radiograph image display monochrome monitor and the inspector reports from this displayed image. On completion of this the radiograph image is authorised, archived and the system is available for the next product.



Imaging

The main benefits are that the digital imaging plates are flexible & reusable several times (with proper care 10,000 to 15,000). The second benefit is that the imaging plates have a much wider dynamic range than film. The third is that there are no chemicals or wet chemistry requirements.

System Qualifications

Over the recent years several system qualifications have been specified. Recent ASTM 2002, 2033, 2077 ,CEN EN standards have advocated the use of duplex dual wire IE462 known as CERL IQI to be used to gauge the systems radiographic unsharpness coupled with IQI wire type.

NDT Digital Radiography Inspection with Pipework

This has now been applied with the CIT system technology. The results obtained are as follows:

No	CIT systems Performance used	Duplex IE462 wire Assessment
1	DR1200 Digital radiography system [42.3micron scanning resolution]	12th line pair 0.13mm [0.063mm diameter]
2	DR1000 Digital radiography [60 micron scanning resolution]	11th Line a pair 0.15mm [0.080mm]
3	DR1400 Digital radiography system [35micron scanning resolution]	12/13th line pair 0.13mm [0.063]mm/[0.10mm (0.050mm)]

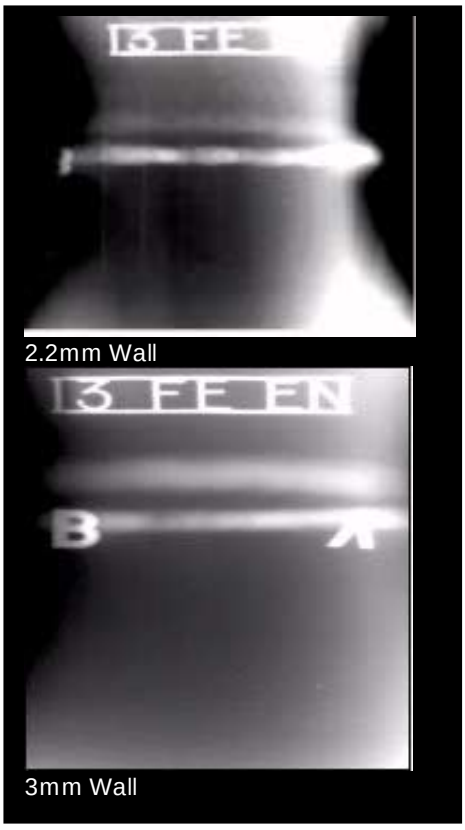
Thin wall Pipe weld radiography results

These results were generated using :

- ✓ **CIT/Dr1000 Digital Radiography Technology**
- ✓ **Portable CP160kV X-ray generator [0.8mmX0.8mm]**
- ✓ **Using DWSI radiographic technique exposure method**
- ✓ **Flexible Digital Imaging plates CIT/STD5070**
- ✓ **Appropriate IQI**
- ✓ **Pipes of following diameters**

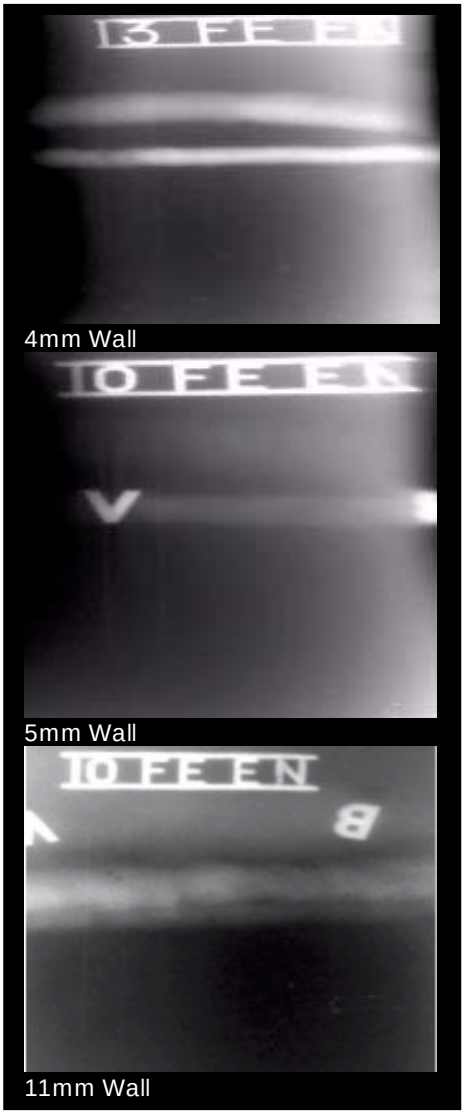
No	Pipe Diameter	Wall Thickness	IQI used	Sensitivity achieved
1	2"	2.2mm	13FE	5th Wire – 1.8%
2	2.5"	3mm	13FE	4th Wire – 1.6%
3	2.4"	4mm	13FE	4th Wire – 1.25%
4	2.5"	5.5mm	10FE	4th Wire – 1.8%
5	4"	11mm	10FE	3rd Wire – 1.13%

The radiographic images are illustrated below



2.2mm Wall

3mm Wall



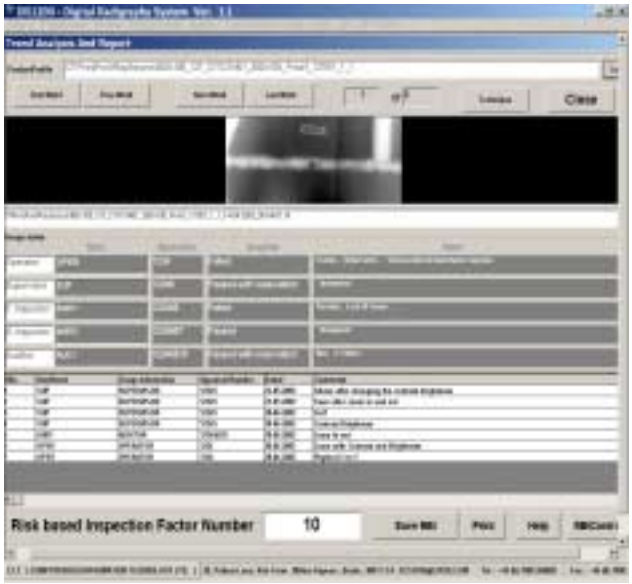
4mm Wall

5mm Wall

11mm Wall

CIT/Digirad Technology

With the CIT's Digital Radiography System the radiographic results are presented in product report format. A typical product report is illustrated



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The radiographic sensitivity and resolution is computed in the same way as the film radiography. The standards, stipulated by various nuclear & Petrochemical specifications are met by CIT's system are being met. The radiography setup of DWSI and SFD of 75mm to 200mm was used during the tests.

Another equipment used was the battery powered portable 120kV CP minifocus. The unit has the added advantage that it is a hand carried with out any cables and the total weight is only 6.5Kg. This makes it an Ideal Companion where portability is required

Digirad Interpretation of Radiographic Images

CIT/ Digital technology uses high-resolution black and white display technology. With its diagnostic quality the inspectors can interpret directly from this radiograph monitors. For interpretation, there are several electronic tools available for the inspectors' use: -

- Zoom in/out of the image.
- Density/ Window levelling.
- Distance calibration and measurement.
- Point densitometer
- Defect sizing
- Line profiles and advanced density difference plots, Graphs
- Annotation and save setting
- Writing comments on the radiographic image and saving.
- Attach Document and review.
- Reference image for comparison etc.
- On stream standard codes.
- Electronic signatory for authentication
- Security access
- Reporting and scanning/printing

The above powerful tools will save the inspectors significant time.

Training

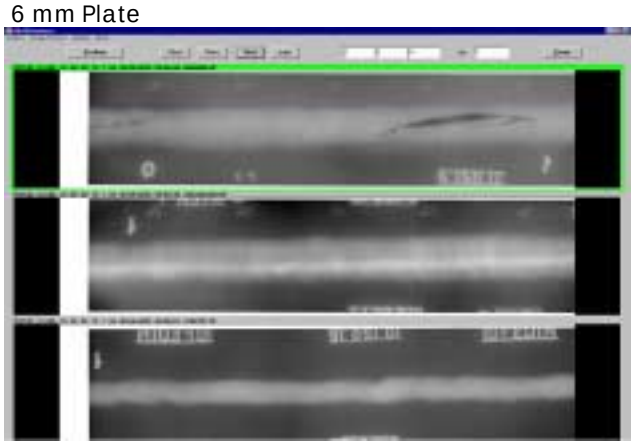
CIT provides the training for the use of the Digital Radiography System & the techniques which is in line with the European CEN EN473 guidelines

Business Benefits

Enterprises, small to medium sizes companies, NDT test houses that adopt the Digital radiography can derives commercial benefits immediately. These benefits which are:

1. Cost savings on X-ray films
2. Cost saving on chemicals
3. Cost savings on water and chemical disposable
4. Cost saving on administrative efforts on archives and film management
5. Cost savings on storage space,
6. Electronic archives of the data & faster retrieval of NDE information data.
7. On-Line Information access
8. Improved Productivity & Profitability

6 mm Plate



Basic Differences between European and North American Radiography

Of cause there are no differences in Physics on both sides of the world, but traditions and rules for radiography are quite different. This is due to the historical development and national specialties.

Each radiographer must know the following basic standards:

- EN 444 General rules ISO 5579
- EN 1435 Welding, Pipe weld Inspection
- EN 12681 Foundry (Casting)
- ASTM E2007-00 Standard guide for determining total image unsharpness in radiography
- ASTM2033-99 standard Practice for Computed radiography
- DG SPS 5108 – Defence Procurement MOD. Non-destructive examination requirements for Nuclear requirement
- ASME V Article II on Digital Imaging
- Rolls Royce RP5720/RP5704 radiographic specifications
- CEN EN473 Training guide line for radiography

The idea behind these standards is: Standards shall guarantee a **minimum image quality** under '**Minimum Requirements'** for the testing procedure. This is basically:

- **Contrast**- optical Density, IQI-values, max. X-ray energies,
- Wall thickness limits for gamma sources
- **Digital Imaging plate classes**-definition of Digital imaging system classes in dependence on energy and wall thickness
- **Unsharpness**- minimum focus-object-distances
- **Handling**- Radiation geometries, Filter, Shielding, Masking, Marking

Summary/ Conclusion

The technology described is a serious alternative to existing methods. Every organisation should evaluate and consider applying technology. The digital radiography technology is here to stay and to be used in mission critical environment. In addition provides the extra cost savings that enterprises have been struggling to establish.

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